NATIONAL UNIVERSITY

Syllabus
Department of Zoology

Four Year B.Sc Honours Course
Effective from the
Session : 2009–2010

National University
Subject: Zoology
Syllabus for Four Year B.Sc. Honours Course
Effective from 2009-2010 Session

Course content and marks distribution

Course Code	Course Title	Marks	Credits
	Introduction to Zoology	100	4
	Protozoa and Non-chordates	100	4
	Environmental Biology	100	4
	Zoology Practical-I	100	4
	Chemistry-I/Biochemistry-I	100	4
	Chemistry Practical-I/Biochemistry-I Practical	50	2
	Botany-I	100	4
	Botany-I Practical	50	2
	Total =	**700**	**28**

Course Code .....: Introduction to Zoology Marks 100, 4 Credits, 60 Lectures

1. **Introduction**
   Concept, history and scope of zoology, subdivisions of zoology, application and importance of zoology, relation of animals to human.

2. **Origin of Life**
   Spontaneous generation, special creation, cosmic, naturalistic and recent theories.

3. **Foundation of Animal Life**
   Origin of life – major stages in the early evolution of life (e.g. Stage I – Molecular, Stage II – Polymeric, Stage III – Semi-biotic and Stage IV – Cellular); level of organization (protoplasmic, cellular, tissue, organ, organ system, organism, species, individual, population, community, fauna, biota, ecosystem, biosphere and biodiversity).

4. **Fundamentals of Cytology and Histology**
   Cells – cell and cell theory, structure and function of cell membrane, organelles and nucleus; chromosomes structure and function; nucleic acid, replication of DNA; gene – nature, chemical composition and action; cell cycles and cellular differentiation, cell division; tissue – types, structure and function.

5. **Basis of Animal Classification**

Body forms (sexual, developmental and polymorphic), symmetry, polarity of the body, metamerism, tagmatization, appendages (flagella, cilia, antenna, styles, poda, fins, wings and limbs); embryogeny (radial, spiral, determinate and indeterminate cleavages; germinal layers and coelom types); protostomia and deuterostomia; morphometrics and meristics.

6. **Classification of Animals**
   Number of kingdoms; classification up to phyla on the basis of organization, symmetry, coelom and phylogeny; different taxa and Linnaean hierarchy and nomenclature.

7. **Methods of Studying Animals**
   Collection, sampling, transportation, preservation, identification and tagging.

8. **Instrumentation in Zoological Studies**
   Microscopy, configuration, incubation, balance, collecting devices and kits, microtomes, habitat analysis kits, haemocytometer, sphygmomanometer, photography, camera lucida and micrometer.

9. **Scientific Report Writing**
   Title, by line, abstract, key words, introduction, acknowledgements, study area, material and methods, results, discussion, and literature cited (reports should also contain tables, photographs/illustrations and maps).

10. **Informatics**
    Retrieval of literature and information databases; software for biological studies.

Course Code .....: Protozoa and Non-chordates Marks 100, 4 Credits, 60 Lectures

1. **General characters with examples of protozoans, mesozoans and parazoans; radiate, acelomate and pseudocelomate animals.**

2. **Broad classification of the following phyla up to orders with general and diagnostic characteristics of each taxonomic category with examples and affinities:**

   Sarcomastigophora, Apicomplexa, Ciliophora, Porifera, Cnidaria, Platyhelminthes, Annelida, Nematoda, Mollusca, Arthropoda, Echinodermata and Hemichordata.

3. **Type study of the following with their origin, evolution, systematic position, habitats, external morphology, organ systems such as digestion, movement, circulation, respiration, excretion, nervous, reproduction, food and feeding habits, mode of life and development.**
   a. **Phylum Sarcomastigophora:** *Euglena*

b. **Phylum Apicomplexa:** *Eimeria*
c. **Phylum Ciliophora:** *Paramecium*
d. **Phylum Porifera:** *Scypha*
e. **Phylum Cnidaria:** *Obelia* and *Aurelia*
f. **Phylum Ctenophora:** *Hormiphora*
g. **Phylum Platyhelminthes:** *Taenia*
h. **Phylum Nematoda:** *Ascaris*
i. **Phylum Acanthocephala:** *Macracanthorhynchus*
j. **Phylum Mollusca:** *Pila* and *Lamellidens*
k. **Phylum Annelida:** *Neanthes*
l. **Phylum Onychophora:** *Peripatus*
m. **Phylum Arthropoda:** prawn and grasshopper
n. **Phylum Bryozoa/Ectoprocta:** *Bugula*
o. **Phylum Brachiopoda:** *Lingula*
p. **Phylum Chaetognatha:** *Sagitta*
q. **Phylum Echinodermata:** *Asteropecten*
r. **Phylum Hemichordata:** *Balanoglossus*

4. Brief notes on the following including habits, habitats, and food and feeding –

a. **Sarcomastigophora:** *Trypanosoma*, *Leishmania*
b. **Ciliophora:** *Vorticella*
c. **Porifera:** *Spongilla*
d. **Cnidaria:** *Physalia*, *Gorgonia*
e. **Ctenophora:** *Bero*
f. **Platyhelminthes:** *Fasciola*, *Schistosoma*
g. **Nematoda:** *Meloidogyne*
h. **Sipuncula:** *Sipunculus*
i. **Mollusca:** *Dentalium*, *Loligo*, *Octopus*
j. **Annelida:** *Chaetopterus*, *Tubifex*
k. **Arthropoda:** *Balanus*, *Scolopendra*, housefly, *Drosophila*
l. **Echinodermata:** *Echinus*, brittle star

Course Code .....: Environmental Biology Marks 100, 4 Credits, 60 Lectures

1. Concepts and scopes of environmental biology.

2. Pollution: definition and types –
a. Air pollution – sources, effects, types and control measures.
b. Water pollution – sources, effects, types and treatment.

c. Soil pollution – sources, effects and prevention.
d. Noise pollution – sources, effects and prevention.

3. **Use of agrochemicals:** Types, reasons for use, effects and impacts on environment.
4. **Environmental Impact Assessment (EIA).**
5. **Environmental management and development planning.**
6. **Sewerage disposal, garbage and waste management.**
7. **Global climate change.**
8. **Acid rain and its impact on environment.**
9. **Deforestation and afforestation.**
10. **El Nino and La Nina.**
11. **Disaster management:** Earthquake, flood, cyclone, tidal surges, drought, river erosion with particular reference to Bangladesh.
12. **Arsenic problem in Bangladesh.**
13. **Salient features of the Bangladesh Environment Conservation Act 1995, and Bangladesh Conservation Rules 1997.**

Course Code .....: Zoology Practical-I (time: 6 hrs in one day) Marks 100, 4 Credits, 90 Hours Practical Classes

1. **Study of museum specimens:** Representative of all major non-chordate phyla (minimum 50 specimens to be studied).
2. **Study of permanent slides:** Whole mount, body parts and various cells and invertebrate tissues (at least 20 slides to be studied)
   a. Whole animals – representatives of protozoans, rotifers and arthropods.
   b. Mouth parts of arthropods.
   c. Parasites – nematodes and platyhelminths.
   d. Different larval forms of invertebrates.
   e. Histological slides of invertebrates.
3. **Preparation and study of whole mounts of different non-chordates.**

4. **External morphology and dissection of various organ systems of earthworm, cockroach, prawn, *Pila* and *Lamellidens*.**

    a. Digestive system of prawn, *Pila* and *Lamellidens*.
    b. Circulatory system of earthworm and prawn.
    c. Nervous system of cockroach, grasshopper, prawn, *Pila* and *Lamellidens*.
    d. Reproductive systems of earthworm, cockroach, grasshopper and prawn.

5. **Temporary mounting –**
    a. Brain of earthworm.
    b. Salivary gland of cockroach.
    c. Statocyst of prawn.

6. **Study of appendages (locomotory, prehensile, food capture, copulatory, defensive and offensive organs of cockroach and prawn).**

7. **Field visit to observe local invertebrate fauna,** or **field visit to a farm, and prepare a report on the visit.**

Distribution of Marks for First Year Final Examination

1. Major dissection (dissection 10 + display 2 + drawing and labeling 6) **= 18 marks.**
2. Minor dissection (dissection 5 + display 2 + drawing and labeling 3) **= 10 marks.**
3. Temporary mount (staining, mounting and display 5 + drawing and labeling 4) **= 9 marks.**
4. Spotting of museum specimens – 15 items (identification and classification 1 + diagnostic characteristics 1) **= 30 marks.**

a. Invertebrate specimens (9 items) 2 × 9 = 18 marks.
b. Whole mount slides (mouth parts, parasites, larvae) (3 items) 2 × 3 = 6 marks.
c. Histological slides (3 items) 2 × 3 = 6 marks.

5. Appendages (detachment, placement and drawing on a paper sheet 4, labeling 3, displaying 1) = **8 marks.**
6. Report writing on field visit = **15 marks.**
7. Class records = **10 marks.**

Books Recommended:

1. C. P. Hickman and L.S Roberts. 1995. *Animal Diversity* Wm C. Brown
2. J.W. Nybakken and J. McClintock 1996. *The Diversity of Invertebrates: Gulf of Mexico Version. Wm.* C. Brown
3. L.S. Dillon. 1976 *Animal Variety: An Exolutionary Account.* Wm. C. Brown Company Publishers. Dubuque. Iwoa

4. J.D. Bernal. 1969. *The Origin of Life.* Weidenfeld and Nicolson. London.
5. G.B. Wilson and J. H. Morrison. Cytology. Affiliated East-West Press Pvt. Ltd. New Delhi
6. E.E. Ruppert and RD. barnes 1994. Invertebrate Zoology (6th edition). Saunders College Publishing Harcort Brace College Publishers. New York, London.
7. R.S.K. Barnes, P. Calow and P.J.W. Olive, 1993. *The Invertebrates A New Synthesis Blackwell*
8. A.J. Marshal and W.D. Williams. *Text Book of Zoology Invertebrates (*edited the 7th edition of Text Book of Zoology. Vol 1, T. J. Parker and W.A. Haswell)
9. P. Wilimer 1990. *Invertebrate Relationship: Patterns in Animal Exalution CUP.*
10. J.W. Knudsen *Biological Techniques. Collecting. Preserving an Illustrating Plants and Animals. Harper and Row.* New York, John Weather Hill Inc. Tokyo.
11. E.O. Wilson T. Eisner and W.R. Brigges. *Life Cells. Organist Populations.*
১২. M. Sleigh 1989. *Protozed and other protists.* Chapman and H. Inc. New York.
১৩. C. Starr and R. Taggart 1981. *Biology: The Unity and Diversity life.* Wadsworth Publ. Co. Belmant, California.
14. J. W. Nybakken. 1996. *The Diversity of Invertebrates a Laboratory Guide.* Pacific Coast Version. Wm. C. Brown
15. R.P. Dales. 1981. *Practical a invertebrate Zoology.* Blackwell Scientific Publications. Oxford. London
16. R.L Wallace and W.K. Taylor. 1996 *invertebrate Zoology* Laboratory Manual Practice-Hall
17. স্নাতক প্রাণিবিজ্ঞান, (প্রোটোজোয়া এবং নন-কর্ডাটা), সম্পাদনা প্রফেসর মোঃ নাজিম উদ্দিন, নিসর্গ প্রকাশনী-বাংলা বাজার, ঢাকা ।(২০০৪)
18. প্রাণিবৈচিত্র-প্রথম খন্ড-অমেরুদন্ডী প্রাণী-২০০৪, ডঃ স্বপন কুমার দত্ত এবং অন্যান্য, মলিক ব্রাদার্স-বাংলা বাজার, ঢাকা ।
19. প্রাণিবিজ্ঞান পরিচিতি-২০০৩, ডঃ মোঃ আলতাফ হোসেন এবং অন্যান্য, মলিক ব্রাদার্স, বাংলাবাজার, ঢাকা
20. মাইনর ফাইলা, প্রফেসর খান ও ডঃ করিম
21. প্রাণিবিজ্ঞানের ভূমিকা, আবু মাসুদ, গোব লাইব্রেরী (প্রাঃ) লিঃ,বাংলা বাজার, ঢাকা ।
22. প্রাণিবিজ্ঞানের প্রথম পাঠ-প্রফেসর কে. এম. আওরঙ্গজেব, কবির পাবলিকশেন ।
23. E.A. Laws 2000. *Aqua Pollution. An Introductory* Text. Wiley
24. R.B. Clark. 1997. *Marine Pollution.* Clarendon Press (OUP)
25. F.C. Cuny . *Aim and Scope of Disaster Management.* Asian Institute of Technology, Bangkok, Thailand.
26. M. Saidur Rahman. 1992. *Disaster Management Handbook for Bangladesh* Vols. I-V Bangladesh Disaster Preparedness Centre, Dhaka.
27. M.A. Choudhury. 1991. *Cyclone in Bangladesh*
28. C.*W. Nick 1991. Disaster Management A Disaster Managers Handbook*. Asian Development Bank ADB), Manila, the Philippines.
29. A. Rahman. 1990. *Human Response to Natural Disasters: Issues Involved.*
30. R.L. Peters and T.E. Lovejoy, 1994. Global Warming and Biological Diversity Yale UP, USA.

Course Code .....: Chemistry-I Marks 100, 4 Credits, 60 Lectures

1. **Measurements and the Scientific Method:** Measurements, units, SI units, reliability of measurements – precision and accuracy, rounding off, significant figures, significant figures in calculation, mean and median, errors, sources of errors.
2. **Structure of atom:** Atom , isotopes, atomic masses, mass spectroscopy, atomic nucleus, nuclear binding energy, nuclear reactions –fission and fusion reactions, Bohr atom model, spectrum of atomic hydrogen, dual nature of electron, Heisenberg uncertainty principle, quantum numbers, atomic orbitals, Aufbau principle, pauli exclusion principle, Hund's rule of maximum multiplicity, electronic configuration of atoms.
3. **Periodic Table:** Periodic law, periodic table, electronic configurations from the periodic table, periodic properties of the elements such as ionization energies, electron affinity, electro negativity, atomic/ionic radius along a period and down a group, diagonal relationship
4. **Chemical Bonds:** Chemical bond, types of chemical bonds – ionic, covalent coordination, metallic, hydrogen, polar and no polar covalent bonds, Lewis dot structure, shapes of molecules, VSEPR theory, valence bond theory, hybridization, σ- and π-bonding in compounds, molecular orbital theory.
5. **Oxidation and reduction:** redox reactions, writing and balancing redox reactions**,**
6. **States of Matter:** Comparison between solids, liquids and gases, changes of state, m.p. and b.p, phase transition, phase diagram of water.
7. **Gaseous and Their Properties:** The gas laws , the perfect gas equation, the kietic theory of gases, Van der waals equations, real gases, Graham's laws of diffusion and effusion.
8. **Solutions:** Solubility and intermolecular forces, solubility product, types of concentration units, colligative properties, of solutions, Henry's law, Nernst distribution law.
9. **Acids and Bases:** Various concepts on acids and bases, conjugate acids and bases, neutralization reactions acid- base strength, pH, acid-base titrations, acid-base indicatiors, acid-base properties of salts, the common ion effect, buffer solutions, hard and soft acids and bases.
10. **Chemical Equilibrium:** Reversible reactions and the equilibrium state, the equilibrium law, reaction quotients and equilibrium constants, calculations using K_c, K_p.

    Homogeneous and heterogeneous equilibria, the principle of Le Chatelier and Brown.
11. **Hydrocarbons**: Hydrocarbons, saturated and unsaturated hydrocarbons, alkanes, alkenes, and alkynes, nomenclature of organic compounds- the IUPAC system natural gas, petroleum, petrochemicals.
12. **Study of different classes of organic Compounds:** Alcohols, aldehydes, ketones, carboxylic acids, esters, amines and amides.

Books recommended:

1. General Chemistry, D. D. Ebbing, Houghton Miffin Co.

2. Chemistry – The Molecular Nature of Matter and Change, M. Siberberg. WCB /Mc Graw-Hill.
3. Introduction to Modern Inogranic Chemistry, S.Z. haider, Friends' International.
4. Principles of physical chemistry, M. M. Huque and M. A Nawab, students' publications.
5. Essentials of Physical chemistry, B.S Bahl, G.D Tuli and A Bahl, S. Chand & Co.Ltd.
6. Advanced Organic Chemistry, B.S. Bahl and A Bahl, S. Chand & Co. Ltd.
7. A Level chemistry by C.W. Ramsden
8. Organic Chemistry: T Morrison and R.N Boyed,
9. Fundamental of Organic Chemistry by W Solomons

Course Code .....: Chemistry-I Practical Marks 50, 2 Credits, 30 Lectures

1. Preparation of $FeSO_4$ $7H_{2O,}$ Mohr's salt and potash alum.
2. Separation and identification of four radicals from a mixture of anions and cations The cations are pb^{2+}, cu^{2+}, Cd^{2+}, Al^{3+}, Fe^{2+}, Fe^{3+}, Co^{2+}, Ni^{2+}, Zn^{2+} Ca^{2+}, Ba^{2+}, Na^{+}, $K^{+,}$ and NH_4^{+}, the anions are $NO_{3,}$ $CO_3^{2-,}$ $S^{2-,}$ $SO_4^{2-,}$ Cl , Br and I^{+}
3. Standardization of NaOH solution using standard oxalic acid solution,
4. Determination of Fe^{2+} using standard permanganate solution
5. Iodometric determination of copper(II) using standard Na_2SO3 solution.
6. Gravimetric determination of nickel as $Ni(HDMG)_2$ complex
7. Determination of the enthalpy change for the decomposition sodium dicarbonate into sodium carbonate.
8. Determination of the p^H- neutralization curves of a strong acid by a strong base.
9. Investigation of the conductance behaviour of electrolytic solution and applications (acetic acid)
10. Determination of the presence of nitrogen, halogen and sulphur in organic compounds.
11. Identification of the functional groups (unsaturation, alcohol, phenol, carbonyl, aldehlyde, ketone, carboxylic acid, aromatic amine, amide and nitro- groups) in organic compound.

Books Recommended:

1. A Text Book of Quantitative Inorganic Analysis, A.I. Vogel, $3^{rd}/4^{th}$ edition, ELBS and Longman Green & Co. Ltd.
2. A Text Book of Quantitative Inorganic Analysis, A.I. Vogel 3^{rd} /4^{th} edition, ELBS and Longman Green & Co. Ltd.
3. Practical physical chemistry, A Faraday.
4. A Text Book of practical organic chemistry, A.I. vogel, ELBS edition.

Course Code .....: Biochemistry-I Marks 100, 4 Credits

To be posted

Course Code .....: Biochemistry-I Practical Marks 50, 2 Credits

To be posted

Course Code .....: Botany -I Marks 100, 4 Credits, 60 Lectures

1. Introduction: Origin and evolution of life; differences between plants and animals; modern concepts of classification of living organisms.
2. Microbiology:
   a) Introduction to Viroids, Prions, Rickettsia and Mycoplasma.
   b) Virus: Physical and chemical nature of phage, plant and animal viruses, multiplication of HIV virus and economic importance.
   c) Bacteria: Types, fine structure, reproduction and importance.
   d) Fungi: Habitat, characteristics, classification up to class (Alexopoulos), reproduction, importance, life history of *Saccharomyces.*
   e) Cyanobacteria: Habitat, characteristics, structure, importance of Cyanobacteria .
   f) Algae: Habitat, characteristics, classification up to class (Fritsch), reproduction, importance; life history of *Oeodogonium*.
   g) Phytoplankton: Habitat, characteristics, classification and importance.
3. Lichen: Habitat, characteristics, classification and importance.
4. Limnology: Definition, scope, importance and classification of lakes.
5. Bryophyta: Habitat, characteristics, classification up to classes and reproduction; life history of *Riccia* and *Anthoceros*.
6. Pteridophyta: Habitat, characteristics, classification up to classes, importance; life history of *Selaginella* and *Christella*.
7. Gymnosperms: Habitat, characteristics and importance*;* life history of *Cycas* and *Gnetum*.
8. Angiosperms: Habitat, characteristics, ICBN, classification systems of plant kingdom. (Artificial, natural & phylogenetic). Identifying characters and economic importance of the following families: (a) Fabaceae, (b) Solanaceae and (c) Malvaceae and (d) Poaceae.
9. Plant Pathology: Concept of diseases in plants, causes, diagnosis, classification and importance of plant diseases, symtomatology and control measures; forecasting of plant diseases.

Causal organisms, symptoms and control measures of brown spot of rice, stem rot of jute, citrus canker and tungro disease of rice.

10. Economic Botany: Local and scientific names, parts used and importance of at least 8 prominent plants of each of the following groups: (a) Food, (b) medicine, (c) timber, (d) fibre, (e) oil and (f) vegetables. Cultivation and processing of tea and rubber.

Books Recommended

1. Agrios, G.N. 1997 : Plant Pathology (4th ed.). Academic Press, London.
2. Bold, H.C. and M.J. Wynne. 1978 : Introduction to the Algae, Prentice Hall, India
3. Hawker, Lilian, E. 1967 : Fungi, Hutchinson Univ. Library, Cambridge Univ. Press, London.
4. Lawrence, G.H.M. 1951 : Taxonomy of Vascular Plants. The Macmillan Co. New York.
5. Pelczer, M.J., E.C.S. Chan Book Co. and N.R. Krieg. 1993 : Microbiology: Concepts and Applications. McGraw Hill Inc. New York.
6. Vashista, P.C. 1993 : Botany for Degree Students: Pteridophyta. S.C. Chand & Co. Ltd. Ramnagar, New Delhi.
7. Mukherji, H. and Ganguly, 2000: Plant Groups, Centrl Book Agency, Calcutta.
8. Hill,F.A. 1972. : Economic Botany, Tata McGraw-Hill Publishin Company, India.
9. রায়, শ্যামল কুমার, পাল, নিশীথ কুমার পাশা, মোস্তফা কামাল, ১৯৯৫ : অপুষ্পক উদ্ভিদবিজ্ঞান (১ম ও ২য় খন্ড), বাংলা একাডেমী, ঢাকা।
10. খান, আজমাজদ আলী এবং তরিকুল ইসলাম : স্নাতক উদ্ভিদ বিজ্ঞান ১ম, ২য় ও ৩য় খন্ড।
11. খন্দকার মনিরুজ্জামান, ১৯৯৪ : লিমনোলজী, ঢাকা বিশ্ববিদ্যালয় প্রকাশনা, ঢাকা।
12. বাসার, এম. এ., এম.এ. হাসান এবং ম. রফিকুল ইসলাম. ২০০৪ : উদ্ভিদ বিজ্ঞান, হাসান বুক হাউজ, বাংলা বাজার, ঢাকা।
13 হাসান, এম. এ. এবং এম. কে. আলম. ১৯৯৭ : উদ্ভিদ শ্রেণী বিন্যাস তত্ত্ব (৩য় সংস্করণ), হাসান বুক হাউস, ঢাকা।
14. খাতুন, রাবেয়া, ২০০২ : উদ্ভিদ শ্রেণীবিন্যাস, ইউরেকা বুক এজেন্সি, রাজশাহী।

Course Code .....: Botany -I Practical Marks 50, 2 Credits, 30 Lectures, Time : 6 hours

1. Detail study including dissection (where necessary), mounting, drawing, description and identification with classification of the following genera:
   10

   Cyanobacteria : *Nostoc, anabaena.*
   Algae : *Chlamydomonas, Oedogonium* .
   Fungi : *Saccharomyces* and *Ascobolus.*
   Bryophyte : *Riccia* and *Marchantia.*

Pteridophyte : *Selaginella, Christella.*
Gymnosperms : *Cycas.*
Angiosperm : Poaceae and Fabaceae

2. Identification of the following genera with reasons: 06
   Algae : *Volvox*, *Polysiphonea* and *Fucas.*
   Fungi : *Rhizopus*, *Agaricus*, *Puccinia* and *Penicillium.*
   Lichen : Crustose, Foliose and Fructose.
   Bryophyte : *Anthoceros, Semibarbula.*
   Pteridophyte : *Selaginella*, *Marsilea, Azolla* and *Pteris*
   Gymnosperms : Male and female cones of *Cycas,*
   Angiosperms : Scientific names of common plants around the institution.

3. Find out algal specimens from local fresh water sample; draw and describe. 05

4. Study of the symptoms and causal organisms of Brown spot of rice and stem rot of Jute. 05

5. Detailed taxonomic study of the families as included in the theory syllabus. 08

6. Study of plant and plant parts, and economic uses of angiosperms included in the syllabus. 06

7. Preparation of herbarium specimens of local plants and submission during examination. 05

8. Laboratory Note book. 05

Books Recommended

1. Agrios, G.N. 1997 : Plant Pathology (4th ed.). Academic Press, London.
2. Bold, H.C. and M.J. Wynne. 1978 : Introduction to the Algae, Prentice Hall, India
3. Devlin, M.R. and H.F. Witham. 1986 : Plant Physiology (4th ed.). CBS Publishers and Distributors, New Delhi.
4. Esau, K. 1953 : Plant Anatomy. John Wiley & Sons, Inc., New York.
5. Goodwin, T.W. and E.I. Mereer. 1983 : Introduction to Plant Biochemistry (2nd ed.). Pergamon Press.
6. Hawker, Lilian, E. 1967 : Fungi, Hutchinson Univ. Library, Cambridge Univ. Press, London.
7. Kumar, H.D. 1995 : General Ecology, Vikash Pub. House, India.
8. Lawrence, G.H.M. 1951 : Taxonomy of Vascular Plants. The Macmillan Co. New York.
9. Pelczer, M.J., E.C.S. Chan and N.R. Krieg. 1993 : Microbiology: Concepts and Applications. McGraw Hill Book Co. Inc. New York.

10. Vashista, P.C. 1993 : Botany for Degree Students: Pteridophyta. S.C. Chand & Co. Ltd. Ramnagar, New Delhi.
11. পাশা, মোস্তফা কামাল রায়, শ্যামল কুমার, ১৯৮৬ : ব্যবহারিক উদ্ভিদবিজ্ঞান, বাংলা একাডেমী, ঢাকা।
12. আখতারুজ্জামান, ম. : বংশগতি বিদ্যা, হাসান বুক হাউজ, ঢাকা।
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